

### Introduction

E-bikes are integrating lithium batteries to meet the demands for higher power density, longer life cycles, and improved safety. With emerging infrastructures such as Internet of Things (IoT), e-bikes are facing rapid development, from hardware assembly to service systems. This article provides an overview of MPS's power products that provide simple ways to improve and redefine e-bikes.

### New Energy Metering Solution for Multi-String Lithium Batteries

In a [battery management system](#) (BMS), accurately estimating the internal state of the battery pack poses one of the biggest challenges. Implementing a solution that can accurately monitor the battery's state is critical to improving the device performance as well as user experience.

The [MPF42790](#) is a fuel gauge solution that achieves higher accuracy state-of-charge (SOC) measurements (see Figure 1). The MPF42790 provides the following features:

- Supports 2-string to 16-string battery pack applications
- Monitors up to four temperature sensors
- Single-cell battery SOC monitoring
- Single-cell battery state-of-health (SOH) monitoring
- Customized characteristic modeling for customer batteries

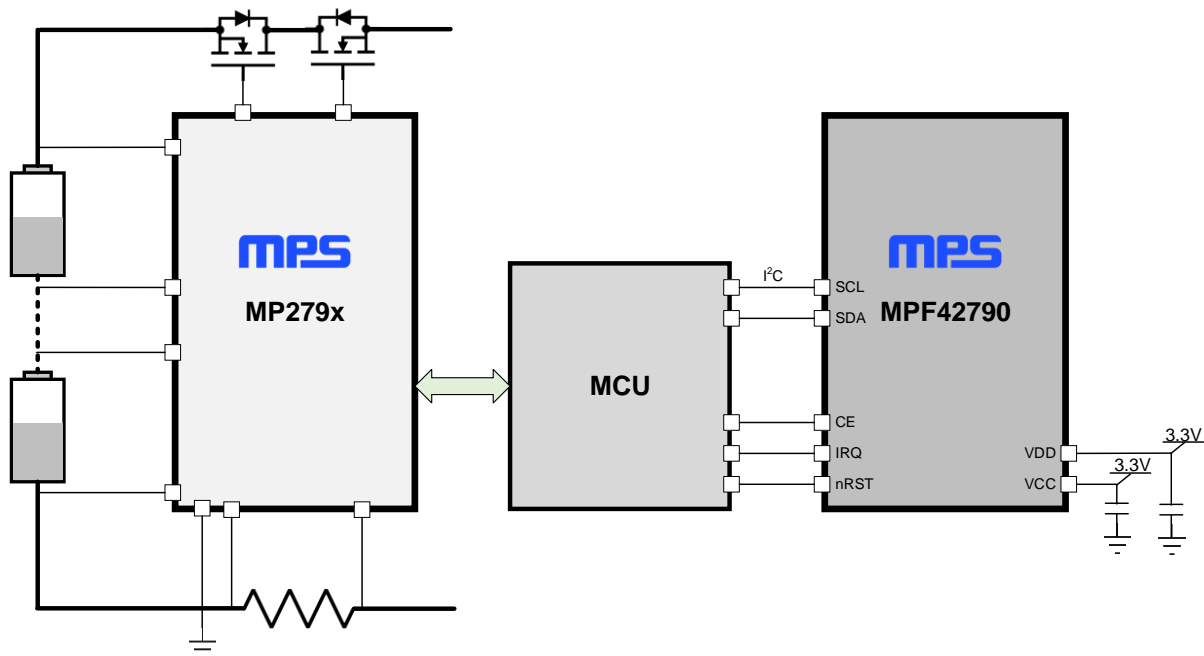
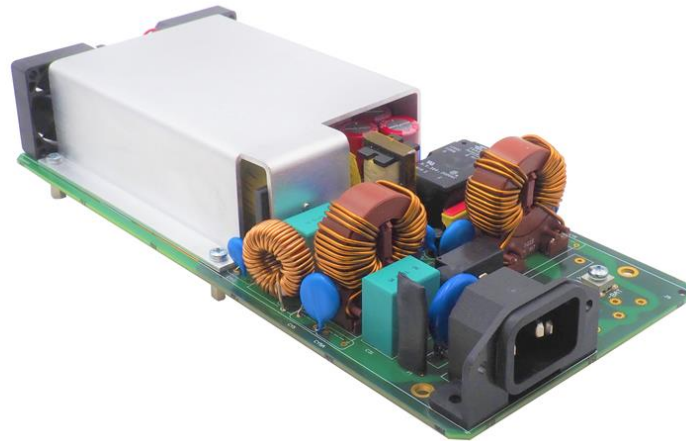


Figure 1: BMS Functional Block Diagram Based on the MPF42790

### A 600W, High Power Density Battery Charging Solution

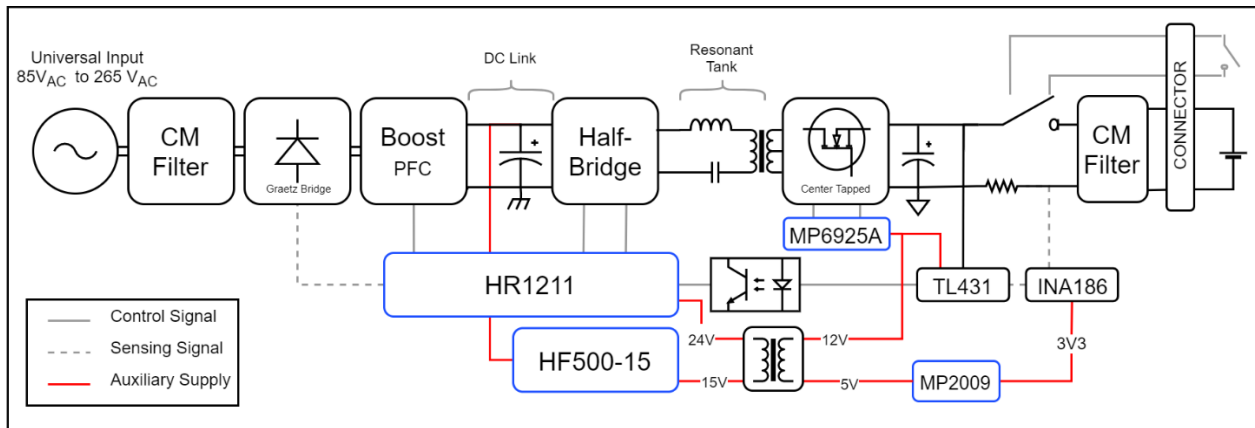
With the rapid development of lithium-ion battery packs, the mainstream demand for high-power charging adapters has emerged. Traditional flyback architecture has proven to be insufficient to meet the frequency, efficiency, and power density requirements of high-power adapters. To meet these requirements, MPS offers the [HR1211](#) as a high-performance, digital, PFC and LLC combo controller.

Figure 2 shows the [reference design board](#) for the [EVHR1211-Y-00B](#), which includes the [HR1211](#), [HF500-15](#), [MP6925A](#), and [MP2009](#).



**Figure 2: EVHR1211-Y-00B Reference Design Board**

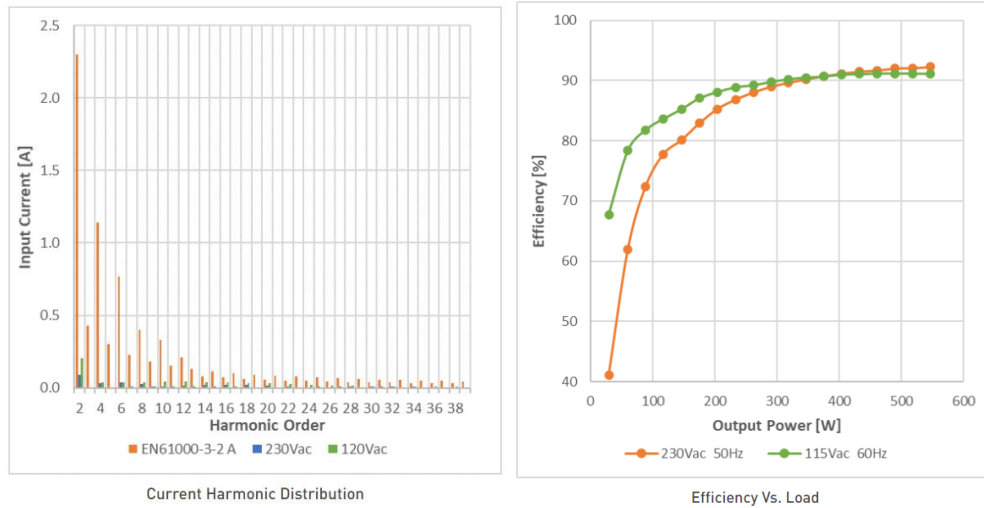
Figure 3 shows the functional block diagram for this design.



**Figure 3: Functional Block Diagram**

The HR1211’s integrated PFC controller eliminates the requirement for low-frequency filters while maintaining an excellent power factor level.

The MP6925A is a related solution that features a synchronous rectification scheme, which replaces the secondary diode. This significantly improves efficiency and ensures that the battery is properly charged through constant-current (CC) and constant-voltage (CV) control. As a result, the solution achieves a higher power density to reduce the overall solution cost (see Figure 4).

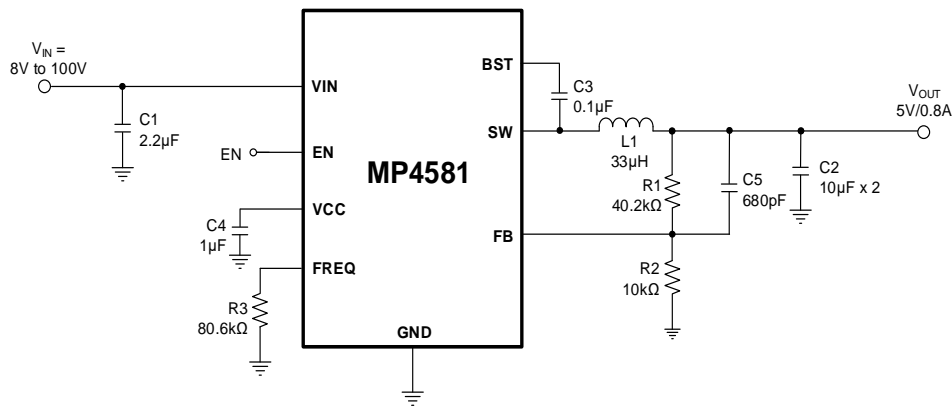


**Figure 4: 600W Charging Solution Performance of the EVHR1211-Y-00B Reference Design**

### 100V, High-Efficiency Step-Down Converter

The rated voltage for battery packs currently ranges from 48V for e-bikes, to at least 60V for light electric motorcycles. When considering the motor’s back electromotive force (EMF) in a BMS scheme, a power chip that can withstand up to 100V is typically required to power the main control and communication on the board.

Figure 5 shows the [MP4581](#), a synchronous [step-down converter](#) that can withstand 100V with a 0.8A load current capability.



**Figure 5: MP4581 Application Circuit**

The MP4581 can reach an input voltage ( $V_{IN}$ ) of up to 100V. It can also automatically enter pulse-skip mode (PSM) under light-load conditions to improve operation efficiency. The MP4581 achieves low standby power consumption with its extremely low 15µA quiescent current ( $I_Q$ ). Figure 6 shows a comparison of the MP4581’s  $I_Q$  relative to similar parts.

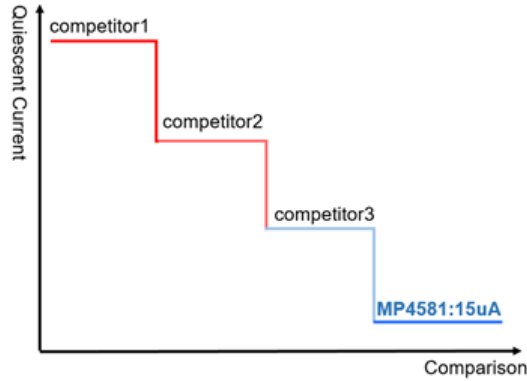


Figure 6: The MP4581’s Low  $I_q$

Figure 7 shows the MP4581’s efficiency curve.

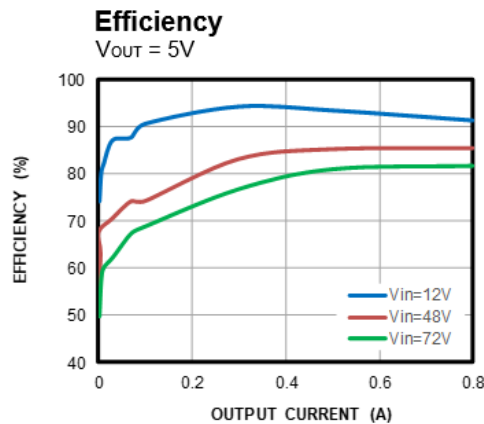


Figure 7: MP4581 Efficiency Curve

### Implementation of a Maximum Power Point Tracking (MPPT) Algorithm for Small Solar Panels Lithium Battery Charging Scheme

More people are becoming accustomed to bike-sharing services as a means of transportation, where riders can quickly use an app to rent bicycles for a certain time or distance. Shared bicycles are typically equipped with batteries, in addition to small photovoltaic panels (a type of solar panel) that power the central control unit.

In a photovoltaic charging system, two key design issues include ensuring that the photovoltaic panels provide maximum power to the shared bicycle central control system, and controlling the backup battery to seamlessly switch between power supplies when there is insufficient light.

The [MP2731](#) is a [single-cell](#) lithium-ion battery charge management solution that is perfectly adapted to photovoltaic input applications. Figure 8 shows the functional block diagram of the MP2731.

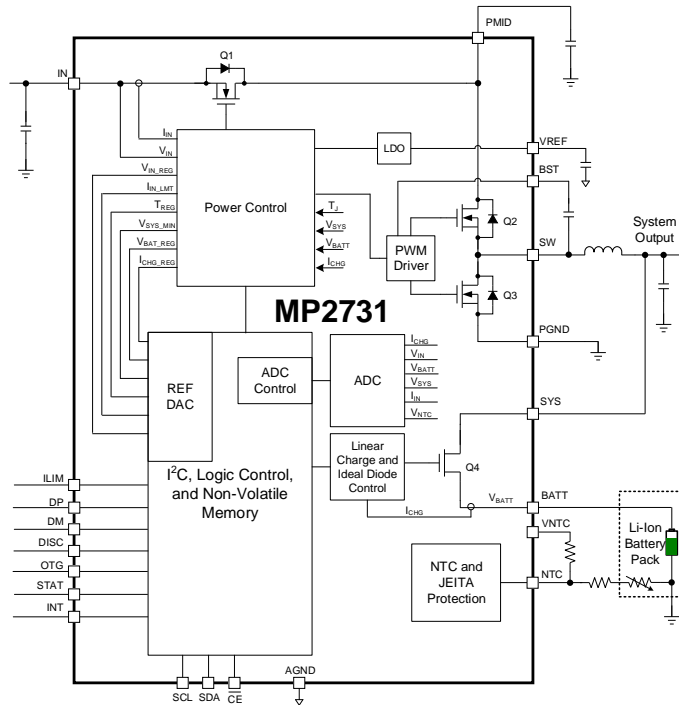


Figure 8: Functional Architecture of the MP2731

Among its cutting-edge features, the MP2731 has three important benefits: an integrated, configurable  $V_{IN}$  loop, a built-in analog-to-digital converter (ADC), and narrow-voltage DC (NVDC) power path management. These features are described below.

- **Configurable  $V_{IN}$  loop:** By controlling the  $V_{IN}$  loop, the photovoltaic panel's output voltage ( $V_{OUT}$ ) can be adjusted easily.
- **Built-in ADC:**  $V_{IN}$  and the input current are collected and converted into digital information, which is then stored in the register. This allows the host computer to calculate the photovoltaic panel's output power ( $P_{OUT}$ ).
- **NVDC architecture:** NVDC power management allows the system to seamlessly switch between using the photovoltaic panel or the backup battery as a power source.

A photovoltaic charging scheme with the MP2731 can efficiently track the maximum  $P_{OUT}$  of the photovoltaic panels, with a tracking accuracy up to 96.8% (see Figure 9).

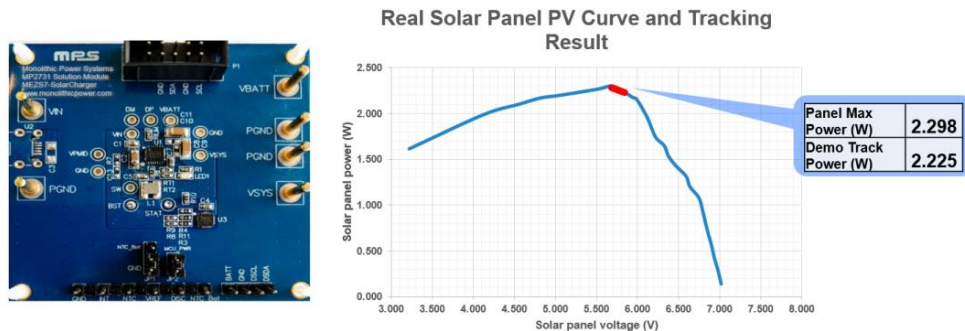


Figure 9: MP2731 Evaluation Board and Measured MPPT Tracking Accuracy

## Conclusion

As e-bikes and bike-sharing services become more widespread, MPS is leading the wave of e-bikes with products such as the [MPF42790](#), [HR1211](#), [MP6925A](#), [MP4581](#), and [MP2731](#). From controllers to battery chargers to converters, MPS can improve e-bike solutions at multiple stages of the design process.

For more information on fuel gauge solutions, see the full [battery management fuel gauge solution](#) with the MPF42790.